

d) said fuselage having indentations along the wing side thereof, and lengthwise of the fuselage[[.]],
characterized in that fuselage and propulsion unit area ruling is defined,

e) said wing leading edge having blunted sharpness along substantially its entire length where the bluntness at each spanwise station is about 1/2% to 3% of the maximum airfoil thickness at said station bluntness defined as h/t where h is the leading edge forward convexity diameter, and t is said maximum airfoil thickness.

R E M A R K S

Claim 1 and other base claims now incorporate leading edge bluntness definition, believed and urged to overcome prior art, as discussed at the interview, so that allowance of all claims is believed in order.

Further applicants has found that an unswept or low sweep wing with reduced thickness, in conjunction with fuselage and propulsion area-ruling, is more efficient for transonic flight, and operates at higher Mach numbers, than a traditional swept wing aircraft. The claimed wing can support extensive laminar flow because of the lack of sweep or low sweep, favorable pressure due to leading edge

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bluntness shaping and the increased laminar flow stability associated with higher Mach number. The result is that drag actually decreases above Mach 0.9, before the inevitable rise near Mach 1, as compared to the steady and rapidly increasing drag with Mach number of swept wing aircraft. This is surprising and unobvious.

The totality of each base claim, as amended, is not suggested by any of the references taken singly or together; and no motivation is shown to combine references in such a way as to reach the unobvious totalities of each base claim, above. Allowance is urged. Examiner's statement of the substance of the interview is affirmed.

COMMENTS OF INVENTOR

The invention claimed in the above patent application Serial No.10/693,411 is fundamentally different from the prior Tracy patents, e.g. 4,322,242 and 6,149,101. The wing of these prior patents relies on low sweep and biconvex airfoils to create conditions favorable to laminar (as opposed to turbulent) boundary layer flow at supersonic speeds. With its attached shock wave, the wing needs to be very thin, in the range of 2% thickness-chord ratio average over most of the span, for reasonable levels of thickness

wave drag. In addition it must have a relatively sharp leading edge (bluntness less than about 1% of airfoil thickness) and little or no camber, since bluntness and camber each add to supersonic drag.

In transonic cruise, the wing described in the Tracy patents, with its relatively sharp leading edge and lack of camber, can develop a separation "bubble" (reverse flow region) on the upper surface, resulting in loss of upper surface laminar flow, and loss of leading edge suction. The latter causes an additional lift-dependent drag penalty which is equal to lift-times-angle of attack, similar to supersonic flight. The loss of laminar flow further increases the total wing drag. These drawbacks are associated with a wing designed primarily for efficient supersonic cruise.

However for an aircraft designed for efficient cruise at transonic speed, it is found that a wing can be made very efficient by slightly blunting and cambering the leading edge. It is shaped so as to create a favorable pressure gradient over much of the upper and lower surfaces, which is necessary to support a laminar boundary layer. In this case the camber and bluntness are configured for a specified range of transonic cruise Mach numbers and lift

coefficients, rather than a hinged leading edge whose primary benefit would be for takeoff and landing.

Specifically referring to Fig. 9(b) of Tracy patent 5,322,242, the leading edge "compound flap" shown mitigates the sharp leading edge separation bubble drag penalty, and improves maximum lift for takeoff and landing. However, it does not ensure laminar flow when deployed due to the step caused by the upper surface flexible plate (85) and the contour break at the lower surface hinge (81) as well. Such a flap would be useful on the sharp-nosed supersonic wing for improved takeoff and landing performance and reduced lift-dependent drag in subsonic cruise as stated, but cannot ensure the desired benefits for efficient transonic cruise.

Most civil aircraft designed for efficient flight at high subsonic speeds at or above about 0.8 Mach employ swept wings with relatively thick airfoils. The notable exception is the Learjet family of aircraft, having low sweep (about 15 degree) and fairly thin airfoils (about 8%). However, the Learjet wing is still too thick for efficient flight above Mach 0.8, and is not capable of substantial amounts of laminar flow. The fastest civil aircraft, the Citation X, has a relatively thick "supercritical" airfoil and substantial sweep. It can fly at speed up to Mach 0.92,

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but its efficiency (and range) drops sharply above about Mach 0.88. Furthermore, along with all such aircraft the swept wing precludes much laminar flow (and can cause undesirable low speed characteristics).

Allowance is respectfully urged.

Respectfully submitted,



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